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IMPACT OF OFFICE AUTOMATION:
AN EMPIRICAL ASSESSMENT

by

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and

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December 1988

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Impact of Office Automation: An Empirical Assessment

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ABSTRACT

This study examined the productivity of the Standard Automated Contracting System (SACONS), in a before/after quasi-experimental design that measured outputs (workload, quality of service), inputs (size of staff, staff grade structure, usage of overtime) and by-product social effects (morale, teamwork, professionalism) using archival data. While workload increased slightly, the quality measure (procurement action lead time) improved over 30% after automation. This result was obtained as the size of the staff decreased. Overtime usage declined sharply after automation. Rather than being perceived as a threat or a source of technologically-induced pathos, the SACONS automation removed drudgery from jobs. Nagging workload backlogs were diminished. Morale, as indicated inversely by sick leave usage, was boosted by the installation of SACONS. Notice was taken of anecdotal evidence and elaboration of time available to assist co-workers strengthened work team cohesion. Time available for training contributed to professionalism. Both factors reportedly heightened worker self-esteem.

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I. INTRODUCTION

Steve Crummey (1988), of Lotus Development Corporation, sized up the current white collar productivity dilemma: "In 1976, at the dawn of the personal computer age, corporations invested $100 million in PC (personal computer) technology. Ten years later in 1986, they spent $46 billion on PCs--and nobody really knows what those dollars are buying."

The goal of this study is to analyze the return on investment in office automation (OA) in terms of increased productivity. A newly installed Standard Automated Contracting System (SACONS), that has been in operation for one year at an Army site we call Ft. Saxon, is studied to assess the impacts of OA on productivity.

SACONS is an automated procurement system. It is a local area network data base management software system that is used to perform various supply functions such as receipt control, large purchase contracting, and small purchase contracting. The focus of our study is on the small purchasing subsystem of the SACONS program, which is for requisitions less than $25,000.

SACONS literature boasts of increased productivity, efficiency and effectiveness. To be more specific, our goal is to empirically test these claims. In doing this, the industrial engineering definition of productivity will be

used: the ratio of output divided by input. It can be seen from this definition that as a measure of output increases, or a measure of the input required decreases, or a combination of the two conditions occurs simultaneously, the productivity ratio becomes larger.

In this case, the inputs studied are the number of people, civil service grade structure and the amount of overtime used. The outputs are purchase request workload and procurement action lead time (PALT). PALT is used as a measure of effectiveness, an indicator of improvement in the quality of the procurement process. The PALT is defined as the difference between the date of awarding of a buy and the date of receipt of the requisition by the purchasing agent.

Our study does what few productivity studies have done, we look at productivity from the industrial engineering model of productivity and we also look at the organizational behavior issues of productivity. Archival data is used to capture empirical evidence of the affects of office automation before and after the implementation of SACONS. The following is a summary of what we study:

- The use of experimental design in data collection and hypothesis testing,
- The affect that SACONS has on the PALT, using archival and current data,
- Empirical evidence of the social impact of SACONS, using archival and current data, and
- The impact of OA on small group dynamics and individual psychology.

II. LITERATURE REVIEW

After spending billions of dollars on automating the offices of white collar workers, organizations find that they must now analyze the computer companies' claims of increased productivity. Computer industry literature such as PC World, Computerworld and Byte reveal that no longer is computerization automatically synonymous with productivity. Organizations such as General Telephone and Electronics (GTE) and Westinghouse are questioning their definitions of productivity in an attempt to provide insight into its measurement.

A. WHAT IS NOT HERE

Several aspects of productivity measurement are not discussed here. First, little in the academic literature that we could find dealt with productivity measurement. Secondly, the measurement of productivity of knowledge workers (professional, technical, managers and administrators) is not the subject of this study. Rather the focus here is on the productivity of clerical workers.

B. BASIC INPUT/OUTPUT MEASUREMENT

The definition of productivity embraced by this study is a ratio of output to input. This industrial engineering definition can be converted to output per worker per hour,

output per unit of material or output per unit of any other physical, measurable or countable unit that describes what an organization does to achieve its goal. (Christopher, 1986) It is a definition under siege.

In defining productivity, Bain (1982) contends that productivity is not a measure of output produced. He says instead that it is a measure of how well resources are combined to accomplish specific results. He explains that a concept of productivity must account for an interplay between factors such as quality, availability of materials, scale of operations, the rate of capacity, the rate of capacity utilization, the attitude and skill level of the work force, and the motivation and effectiveness of management. The way in which these factors interrelate has an important bearing on the resulting productivity.

C. IMMEASURABLE PRODUCTIVITY

Measuring white collar productivity resulting from automation is considered fruitless because it is believed to be difficult to quantify. Borko (1983) cites obstacles such as the difficulty of defining the value and the unit of measure to be used for the output. Goldfield (1983) states that it is difficult to measure the increased speed, accuracy and completeness of reports. Cook (1988) sees difficulty in measuring improved customer service, work quality, timely information needed for decision making and improved employee morale as a result of office automation

(OA). In addition, they found it difficult to measure the increased productivity of repetitive and routine tasks such as manual recalculation, redrafting and editing, and filing and retrieving of information. Borko holds that the work done by white collar workers may not show results until several years later.

A. Perry Schwartz, president of Computer Research Associates, Inc., a software development and consulting firm, claims that with an absence of headcount reduction, there is no easy way to assess improvements in white collar productivity. (Schwartz, 1987) He said that this does not mean that there is no payoff but that measuring the results requires more than just tracing improvements in white collar work to a bottom line. He stated that the output of white collar activity is frequently intangible, uncountable and not easily related to revenue. Therefore, the numbers to make the calculations and build a model to measure productivity are often unavailable.

D. SUBSTITUTING ATTITUDE SURVEYS FOR INPUT/OUTPUT

Another dissent from input/output quantification of productivity argues that quantifying productivity is unnecessary. Instead, Parsons (1987) implies that one method of gauging productivity is to substitute opinion surveys for input/output analysis. Parsons holds that if a worker feels like he is more productive using a computer, then he probably is. Weatherbe (1987) says that a common

mistake made in measuring productivity is focusing solely on labor reduction and not value added to the work. He asserts that job satisfaction is a key indicator of productivity.

E. VARIETIES OF INPUT/OUTPUT ANALYSIS

Sink summarizes input/output definitions of productivity measurement. He gives the following ways in which productivity can be considered improved:

- Output increases while input decreases,
- Output increases while input remains constant,
- Output increases while input increases at a slower rate,
- Output remains constant while input decreases,
- Output decreases while input decreases at a more rapid rate.

Sink defines productivity measurement as "the selection of physical, temporal, and perceptual measures for both input variables and output variables and the development of a ratio of output measure(s) to input measure(s)." (Sink, 1985, p. 25)

Sink says there are two basic categories of pure productivity measures. The first are static productivity ratios in which measures of output are divided by measures of input for a given period of time. The second category are dynamic productivity indexes which give a static productivity ratio at some previous period in time. There are three types of productivity measures within each category:

- The partial factor measure which uses one class of input such as labor or capital,
- the multifactor measure which uses more than one class and,
- the total measure which uses all classes of inputs.

Each of the three types represents a ratio of output to input. However, they differ in terms of how much input is captured in the denominator of the equation.

Sink defined productivity as the relationship between quantities of outputs from a system and quantities of inputs into that same system. Dissecting this definition, it can be seen that the numerator contains an aspect of effectiveness in the way of quality and quantity. While on the other hand, the denominator contains an aspect of efficiency in the way the resources are actually consumed.

Sink states that a measurement system should primarily comprise ratios of output measures and input measures and indexes. The measures of output and input could be specific measures of quantities of any resource used and of quantities of any good or service produced as output.

F. API: LOCALIZED APPLICATION OF INPUT/OUTPUT

Bolte (1983), realized that there was very little practical information available on how to measure and improve administrative productivity and quantitatively control headcount growth. As a result, he created a continuous quantitative system for Intel Corporation that focused on reducing headcount and on improving

administrative productivity. He wanted to dispel the myth that white collar productivity is immeasurable.

Bolte's first step was to define the products of white collar workers by working with administrative organizations. He used the classic definition of productivity by dividing physical units of work output by the number of employee hours required to produce it. He did not use dollars of sales, revenues, cost of payroll, or other financial measures of output or input because he says that his straightforward definition is "understandable, controllable, and workable at the first-time management level, which is where productivity improvements must take place." (Bolte, 1983, p. 47)

Bolte next identified those indicators that directly affected inputs and outputs. First he had each department establish its own quantity and quality goals. Second, the quantity and quality indicators were compared to other units that do the same work. Third, he determined the ratio of direct labor to indirect labor (supervisors) within an administrative organization.

Bolte viewed administrative areas as "paper processing factories" with specific inputs and required outputs so that production line techniques could be used to measure productivity and a base-line index could be calculated. (Bolte, 1983, p. 48) He developed an Administrative Productivity Indicator (API) which can be used where a

single output can be defined as the measure of the performance by an organization. The API is simply work output divided by labor hours input and is expressed in hours per unit (HPU). Its output units must be a physical, countable entity which shows that an organization does what it was organized to do. The input is the hours of work paid for by the organization, minus vacation, absenteeism, and sick leave, during the time in which the output was produced.

The API provides a measure of changes in productivity over time. A beginning HPU is used to determine future productivity trends. After establishing an API, and, in an effort to reduce the base HPU, the next step is to simplify work tasks, apply workload management techniques, and to monitor the API. This will eventually lead to a reduction in headcount, and thus, indicating an improvement in productivity.

G. MOPI: MULTIPLE OUTPUT PRODUCTIVITY INDICATOR

Christopher (1986) includes the Multiple Output Productivity Indicator (MOPI) as a general measure of productivity. This measure, like the API, has been applied in administrative organizations to monitor and improve productivity performance. Unlike an API, a MOPI is used when a single output measure is not considered adequate and several outputs are defined as representing the purpose of a unit. Some of these outputs may be quantifiable while

others require subjective appraisal. In general, to calculate the MOPI, an organization identifies outputs that identify their successful achievement purpose and at the same time can be measured. They then establish a rating scale technique that will ultimately be used to produce a single overall MOPI.

H. CONSENSUS MODEL: LOCALIZED ADAPTATION OF INPUT/OUTPUT

Schwartz (1987) discusses several models that have been used to analyze cost-benefit and measure productivity when direct output models cannot be developed or are infeasible. The Consensus Model was used by General Telephone and Electronics. It projects benefits by seeking agreement among managers on the range of the payoff expected from the introduction of a specific computer technology. Managers are asked to estimate the value of a task and share their estimates and reasoning. After repeated estimates and sharing, a consensus is formed on the dollar value of the production task. The assumption is that an increase in output yields an increase in profit, and an increase in profit is an indicator of increased productivity. It should be noted that these estimates are basically subjective and that this model is used in situations where there is limited quantitative basis for making estimates of value.

I. COST DISPLACEMENT MODEL

In the Cost Displacement Model, inputs can be exactly determined but outputs cannot be measured. (Schwartz, 1987) This model assumes that outputs remain at the current level. Schwartz explains that if outputs actually do remain the same, and inputs such as head counts are cut, then it can be inferred that productivity (output divided by input) has increased, although the absolute amount of the increase cannot be determined.

The Cost Displacement Model requires only that real labor cuts be made or actual equipment savings be achieved. One drawback is that without a real cut in head count or equipment costs, Cost Displacement Models are inappropriate.

J. INFERRED INPUT MODEL

Inferred input models (Schwartz, 1987) are the most frequently used cost-benefit analysis models for information systems. They use projected increases in efficiency and effectiveness among workers rather than actual, verified cuts in labor or head count. In general, these projections are based on the development of a task/time matrix that jointly reflects an amount of time workers devote to activities and the time-saving impact of computer technology. IBM has the most common model of a task/time matrix developed by Booz, Allen, Hamilton (1977). Office professionals were asked to estimate the time they spent in specific activities, such as reading, typing and talking on

the phone. The benefits were than quantified by multiplying the time savings by salary.

This attempt by Booz, Allen, Hamilton in the 1970's was the earliest attempt to develop a method of quantifying the benefits of information technology. Their time-savings/ times-salary (TSTS) model is simple to use but flawed, says Schwartz (1987). Poppel (1982) holds that the flaw in the TSTS model is that it counts time saved on lower value activities as being equivalent to savings on higher value activities. A TSTS cannot distinguish between making a white collar worker a better manager or making him or her a better clerk.

K. WORK VALUE ANALYSIS

Schwartz (1987) and his colleagues have developed a hybrid model called the Work Value Analysis (WVA). WVA evaluates the payoff from computer technology as it affects the effectiveness and efficiency of white collar workers. Schwartz defines efficiency not as input/output but rather as doing things right. He argues that efficiency refers to an additional amount of work accomplished in the same amount of time. He refers to effectiveness as doing the right things. He says that it relates to the amount of time workers spend doing principal activities rather than support activities.

WVA recognizes that not all activities performed by workers directly advance the purpose of an organization.

Therefore, the model accounts for two types of white collar productivity improvements:

- Technology can shorten the amount of time required to complete a given task or it can allow more of the task to be completed in the same amount of time,
- Technology can be the basis for a shift in a work pattern that allows more time to be spent on primary activities and less on lower valued activities such as support, clerical, and lost time. (Schwartz, 1987)

Schwartz identifies the second type of productivity improvement as effectiveness. It is this shift in the work profile that he says produces the most valuable productivity improvement. Using wages as a benchmark, WVA determines the dollar worth of changes in a work pattern. The full model is based on a linear system of constraints requiring a set of simultaneous equations, one for each job level.

Schwartz asserts that a strength of WVA is that it permits objective determination of the productivity payoff when external dollar criteria, relating to profit or value of work, other than salary, cannot be measured or inferred. However, WVA requires considerable effort, such as time logging, to objectively determine work activity profiles.

L. NPMM: NORMATIVE PRODUCTIVITY MEASUREMENT METHODOLOGY

The normative productivity measurement methodology is a result of a two year study of Administrative Computing and Information Services. (Morris and Smith, 1976) It uses a ratio of output to input and a nominal group technique (NGT). Sink describes NPMM as, "A process by which measures

(surrogates), ratios, and/or indexes of productivity can be participatively identified and developed into a measurement, evaluation, control, planning and improvement system." (Sink, 1985, p. 139)

NPMM uses consensus measures of productivity. It involves the execution of NGT to generate a prioritized list of measures for each specified unit of analysis. From this information, a workable productivity measurement system is drafted based on the goals of the organization. The results of this draft are then briefed, reviewed, and discussed with the participants to obtain feedback prior to implementation of the final productivity measurement system. Once the draft has been approved by the organization, a productivity measurement system is integrated into the organizations already existing performance measurements. The final stage requires continuous monitoring and feedback based on the initial calculated ratios.

M. MFPMM: MULTIFACTOR PRODUCTIVITY MEASUREMENT

Multifactor Productivity Measurement is called a total factor productivity model. It is used by the American Productivity Center. MFPMM is a consultative, data base/ accounting system-oriented method. Its primary source of data is not people but system documentation. Sink states that it is diagnostic in a passive, absolute, and objective sense as opposed to an active, relative, and subjective sense. (Sink, 1985) It is a self-contained decision

support system that operates with organizational system data on prices/costs and quantities of output and input resources. MFPP is a complicated model based on weighted performance indexes and their effects on bottom line profit.

MFPP is used because it:

- Obtains an overall, integrated measure of productivity for the firm,
- Accesses and evaluates bottom-line impacts on profitability as a result of productivity shifts,
- Tracks the results of specific productivity improvement efforts.
- Assists with setting productivity objectives and general strategic planning marketing efforts, cost management, and staffing.

Sink also calls MFPMM an objective matrix because it provides a mechanism for developing an aggregate productivity index. It allows for the aggregation and analysis of performance against a variety of criteria.

This methodology can be seen in Felix and Rigg's (1983) description of the Oregon Productivity Center's Objective Matrix and Rowe's (1981) description of the Westinghouse technique of measuring white collar productivity. Employees of a department participate in a brainstorming exercise. They develop a list of priorities. A composite index is calculated for a department by weighting it according to criteria set by management and combining the values into a composite value.

This composite index is used as a basis for measuring the productivity of a specific unit against itself over

time. Once established, management has a system for monitoring white collar productivity. The MFPMM technique is relatively simple and useful for quantifying what has heretofore been regarded as unquantifiable.

N. PRODUCTIVITY MAP

Pacesetter Software has developed a program, called Productivity Map, that purports to measure productivity goals. (Hierl, 1988) Defining productivity as the ratio of goods produced to resources consumed, the program works with measures of productivity such as quantity, quality, timeliness and cost.

Productivity Map uses a survey technique to assess the efficiency of office workers in fulfilling the organizational objectives. It begins by asking managers to define the department's mission. Then it asks workers to rate the importance of the products, services and delivery performance of their departments. Lastly, customers are asked similar questions. When all data are collected the results are displayed on graphs that emphasize quality and timeliness rather than quantitative measures.

O. BOSTI

Buffalo Organization for Social and Technological Innovation (BOSTI) measures the effects of work environment on productivity and quality of work life. (Brill, 1988) They show how certain facets of the office environment

affect job satisfaction and performance. BOSTI believes that productivity can be improved and measured as a result of improvements in office surroundings.

P. WHAT WE FOUND

Having surveyed the literature, we found the following:

- An assumption that computerization of office work always leads to productivity improvement,
- No record of documented measurement of productivity improvement resulting from computerization of office work,
- The beginnings of questioning of the Productivity Assumption that justifies spending on computerization,
- A movement to supplant input/output efficiency definition of productivity with a survey questionnaire assessment of job satisfaction,
- A view of productivity measurement as an adjunct of productivity improvement programs,
- No before/after experimental or quasi-experimental research designs in the study of office automation productivity.

Q. OUR GOAL

Our aim is to:

- Establish an empirical benchmark for productivity gains from office automation,
- Base that benchmark on a before/after experimental design,
- Base a study on hard data measures of an input/output definition of productivity,
- Conduct an office automation productivity study independent of the ameliorative enthusiasms and biasing politics of productivity improvement programs,
- Provide a framework for examining comparative studies of office automation productivity.

III. METHODOLOGY

A. CONDUCT OF THE STUDY

1. Prelude to the Sample

The primary investigators originally intended to sample data from a military purchasing field organization: the purchasing division of the Supply Department, located at NAS Sloat. The selection of this site resulted from our search for an organization which would enable us to address the question, "how does the introduction of computer-supported automation affect productivity?"

At the start of this study, in the summer of 1988, the purchasing division at NAS Sloat processed requisitions with a manual system. However, by the beginning of fiscal year 1989, NAS Sloat was expected to receive the Standard Automated Contracting System (SACONS), a small-purchase software package for use in their purchasing department.[1] Originally developed for the Army, the software was later purchased for use by the Navy.

During discussions regarding the installation of SACONS at NAS Sloat, the Contracting Directorate at Ft. Saxon was identified as having already installed the SACONS system during the fall of 1987. Thus, we turned our

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[1]Hardware for the SACONS system consisted of a standard desk-top system configured as a Local Area Network. Additional hardware information can be found in Appendix A.

attention to the Directorate of Contracting, at Ft. Saxon, as a starting point for this study.

The circumstances involving the SACONS installation provided us with an opportunity to collect data from Ft. Saxon, in a before/after design. That is, before the introduction of SACONS, Ft. Saxon was using a manual requisitioning system.[2] A description of the manual requisitioning system is provided in Appendix B. After the introduction of SACONS, requisitioning was done under computer direction.

Independent of the study and collection of information at Ft. Saxon, we expected to collect measures of performance at NAS Sloat, before their scheduled installation of SACONS. This would let us measure productivity changes at Ft. Saxon, and use that data to estimate changes at NAS Sloat. The actual installation of SACONS at NAS Sloat took place in the fall of 1988 as this study was concluding. This made it impossible for us to measure the direct effects of the SACONS installation upon productivity in the purchasing division at NAS Sloat. By early summer of 1988, our data collection efforts had shifted solely to the Directorate of Contracting at Ft. Saxon.

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[2]Although referred to as a manual system, an IBM system 34 was used to support the purchase process. However, its use was described by Ft. Saxon personnel as essentially that of an electronic typewriter. It did not, in fact, automate the preparation or processing of purchases.

Separate meetings were held preceding the collection of data, between the principal investigators and the supervisory personnel in the purchasing systems at Ft. Saxon. The purpose of this initial meeting was twofold. First, to build a relationship that would reassure the supervisory personnel that our data collection would be done in a manner to have little impact on their operations. Additionally, we assured them that official permission would be obtained before the collection of data. Second, to begin evaluating the measures of performance that could be used in a study of productivity.

2. SACONS Described

SACONS is a computer-based system, designed to support the purchase and contracting efforts of field activities located within the Department of Defense. The system permits real-time access to contracting information by all levels of management, as well as limited access by authorized customers. Access allows a customer to determine the status of his or her requisition. SACONS supports the performance of daily contracting procedures and is designed to meet projected future contracting requirements. SACONS is described further in Appendix C.

3. Experimental Design Development

Having gained access to an organization, we began to develop a means to evaluate productivity. We decided that three types of information would be collected and evaluated:

- Inputs--Quantitative factors in the work place, such as the size of the staff, and overtime worked,

- Outputs--The Procurement Action Lead Time (PALT), PALT is the measure of time it takes to process a requisition and the number of requisitions processed.

- Social Effects--Social effects of automation such as average annual leave and sick leave taken.

4. Analysis

The statistical analysis chosen to evaluate the data is a simple difference of means "t" test.

5. Collection of Data

Archival data from the pre-SACONS manually-processed records was searched by hand in order to establish the baseline for the Ft. Saxon PALT. After the installation of SACONS, requisitions from a SACONS generated listing were sampled in order to provide the PALT.

B. THE SAMPLE

The collection of archival data began in the purchasing division of the Directorate of Contracting at Ft. Saxon. The Directorate of Contracting consists of five divisions which include the Purchasing Division, the Administrative Support Division, the Office of the Director, the Contracting Administration Division, and the Contracting Division. Currently the Directorate of Contracting is staffed with 52 people. The staff consists predominately of civilian women.

C. DATA COLLECTION DESIGN

We sampled archival data from the records maintained within the purchasing division. The following description indicates how the records were sampled in order to estimate the PALT, before and after the SACONS installation.

1. Before SACONS Installation

There were 35,571 requisitions received from 1 October 1986 to 30 October 1987.[3] As a result of the grouping of requisitions, our population consisted of 7,620 individual records. Only one requisition was evaluated per grouping within individual folders. The grouping of requisitions within individual folders occurred when multiple requisitions for similar materials were submitted by one customer. This allowed the awarding of the multiple requisitions as a group to a single vendor.

We randomly selected a sample of five percent from 7,620 records. Using a random number table, we choose the 17th record as our first item. Subsequently, each 20th record was selected, to provide a total of 381 records for evaluation.

2. After SACONS Installation

Selection of the post-SACONS sample was conducted in a similar manner. However, in this case, sample records were selected from a computer generated listing of all post-

[3]Although the installation date for SACONS was November 4, 1987, the total number of requisition actions was determined from reports having an end-of-month date.

SACONS records. The total number of requisitions processed from 1 November 1987 to 30 August 1988 totaled 27,708. Again, due to the grouping of like requisitions, our population consisted of 495 records. Again the 17th record was initially chosen, followed by every 20th record thereafter. The number of requisitions processed per month is provided in Appendix D.

3. Additional Measures

We also gathered archival data on the use of annual leave, sick leave, and overtime worked. We used organization charts and manning tables to determine the number of personnel employed within the Directorate.

Figure 1 represents the interaction of inputs and outputs, both before and after the installation of SACONS at Ft. Saxon. Figure 1 provides a rational or logical means by which to test the null hypotheses for various measures. Testing null hypotheses represents a method in which to determine if data sampled from the before/after periods are statistically the same. If the data are statistically indistinguishable, then the null hypothesis is confirmed. If the null hypothesis is rejected, acceptance of the alternative hypothesis means that the before/after difference in the means is greater than a merely chance occurance.

	$Observation_1$ Before Automation	$Observation_2$ After Automation
Inputs	Staff Size $'s of Labor GS Structure	Staff Size $'s of Labor GS Structure
Outputs	Surrogate for PALT (Logs of manual processing) No. of purchase requests	PALT (Quality) No. of purchase requests

Figure 1. Productivity Matrix

D. INSTRUMENTATION

1. Inputs

Several inputs into the requisitioning process of the Directorate of Contracting were measured. They included:

- The before/after mean annual number of employees,
- The before/after mean annual GS level of the staff,
- The before/after mean bi-weekly amount of overtime worked.

The mean annual number of employees is a measure which indicates the average number of people required to staff the Directorate of Contracting, in order for it to perform its required function. The mean annual GS level of the staff represents the level of expertise required to perform a given task. It also represents a level of payroll expenditure. The mean bi-weekly overtime worked, represents the time spent at the job which was outside of normal

working hours, necessary to complete work. It is usually the result of an increased backlog of work or a temporary reduction of available employees.

We have chosen as our Productivity Measure of Effectiveness[4], the PALT. The PALT is a measure of the quality of work. It represents the time required to process and award a requisition. Requisitions are prepared by military units and submitted to the Directorate of Contracting for purchase. Upon receipt in the purchase division, requisitions are date stamped to begin the PALT period. The requisitions are again date stamped when they are awarded to a vendor, ending the PALT period. When a requisition is awarded on the day it is received, the procurement period counts as one day. The difference between the award date and the date of receipt of the requisition, plus one day, defines the PALT.

A common way in which a change in productivity can be measured is by analysis of the ratio of inputs to outputs. Various inputs into a system or process are required to produce a given output. If the system or process is changed so as to require fewer input resources, or to produce a greater quantity of output, productivity is enhanced. Changes in input or output occur singly or in

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[4]By Productivity Measure of Effectiveness, we mean the quality measure of work in the office environment which represents an amount of productivity that can be measured.

combination, frequently producing a synergistic increase in productivity.

2. Outputs

a. Quality

Outputs of the requisitioning process were measured in two different ways:

- The before/after number of requisitions processed or volume of work performed, and
- The before/after measure of PALT or quality of work performed.

b. Quantity

The volume of work is represented by the mean monthly number of purchase requests processed. This is represented by the average number of requisitions processed each month. The quality of work is a measure of the average time taken to process and award requisitions.

3. Social Effects

During our exploratory discussions with the Directorate of Contracting, anecdotal rhapsodies of SACONS impact on morale and small group dynamics were expressed. These measures included a reduced workload and reduced stress, as well as increased teamwork, increased training, and increased professionalism. We wanted to get some before/after measures to test the reality of these anecdotes.

Social effects are represented by:

- The annual leave taken, and
- The sick leave used.

Annual and sick leave might be characterized as "noise" in the system, in that they are not direct measures of input, or output, in the requisitioning process. However, they represent satisfaction or stress resulting from the work environment in which the requisitioning process occurs.

E. ANALYSIS STRATEGY

1. Procurement Action Lead Time

A difference of means test was applied to the PALT on a month-by-month basis, comparing the manual system used before the installation of SACONS with the automated computerized system used under SACONS. Our null hypothesis is that there is no change in the PALT of the Directorate of Contracting, as the result of the introduction of SACONS.

A sample of five percent of the total records were searched, resulting in the analysis of 876 total records. Three hundred eighty one records were collected representing the PALT taken under the manual system. Four hundred ninety five records were collected from the time after SACONS was installed. We didn't test the hypothesis on work quantity because it was independent of the installation of SACONS. We did however, test null hypotheses for social effect archival measures.

2. Choosing the Appropriate Statistical Test

Student's t-test is appropriate to test hypotheses regarding two populations, where the samples may be either dependent or independent of each other. (Porter and Hamm, 1986) The t-test is applied to test the difference of means of various measures, before and after the installation of SACONS. In the present study, we have sampled independently from two populations.

The samples drawn from each population were treated as independent for the following reasons:

- The pool of employees of the Directorate of Contracting was not identical one-for-one, between the before and after periods. There was normal turnover of personnel as well as a restructuring of job descriptions across the 24 months studied. Associated changes in GS structure between the two periods also took place.
- Employees were not matched one-for-one between the before/after periods. Information on employees regarding age, sex, educational level, and experience level was not collected.

The null hypothesis states that the two populations are statistically the same. (H_0: $X_1 = X_2$) The alternative hypothesis states that the pre-SACONS measure of PALT is greater than the post-SACONS measure to a statistically significant degree. (H_A: $X_1 > X_2$)

The following data are summarized in Table I from the samples drawn from the two populations, before and after the installation of SACONS.

The degrees of freedom for the t-test are 876, which approaches infinity on a standard t-table. A one-tailed

t-test is selected because we are predicting direction. Reading across the standard t-table we find the following significance levels reproduced in Table II.

TABLE I

NUMBER OF ITEMS SAMPLED, STANDARD DEVIATION, AND MEAN (PRE/POST SACONS)

Before SACONS	After SACONS
$N_1 = 381$	$N_2 = 495$
$S_1 = 33.67$	$S_2 = 28.85$
$X_1 = 31.52$	$X_2 = 20.97$

N = Sample size
S = Standard Deviation
X = Mean

TABLE II

T-TABLE SIGNIFICANCE LEVELS

Significance Level	t-score
.05	1.645
.01	2.326

We have chosen the .01 level of significance as the appropriate level in which to test all measures collected.

IV. FINDINGS

A. INPUTS

Measures of inputs to the Directorate of Contracting at Ft. Saxon, were collected and summarized in the following categories:

- Size of the Staff,
- Grade Structure (GS), and
- Overtime worked.

These measures were collected before and after the installation of SACONS.

1. Before Automation

a. Mean Staff Size

The mean size of the staff before automation was 66.69. This represents the period from September 28, 1986 to November 7, 1987. Data were collected from personnel logs maintained for each 2-week pay period. The standard deviation was 6.11.

b. Mean Grade Structure

The mean grade structure (GS) of the directorate was at a 5.985 GS level. This mean was calculated from the organization chart in Appendix E. The standard deviation of the grade structure, before automation, was 2.687.

c. Mean Overtime

Overtime worked by directorate personnel was calculated as the mean of the number of hours worked for the entire staff for each two-week period before the installation of SACONS. The average overtime used was 219.36 hours per pay period, or 3.29 hours per person during each 2-week pay period. The standard deviation was 70.56 hours for the directorate as a whole, and 1.06 hours per person.

2. After Automation

a. Mean Staff Size

The average size of the staff after the installation of SACONS (November 4, 1987) was 62.70 persons. Data were collected from November 8, 1987 to September 24, 1988. The standard deviation was 3.29.

b. Mean Grade Structure

The average grade structure of the staff after automation, as calculated from the personnel chart in Appendix E, was found to be at a 7.212 GS level. The standard deviation was 2.634.

c. Mean Overtime

Overtime for the entire staff of the Directorate per each two-week period was 35.23 hours. Overtime worked on average for each employee was 0.56 hours per 2-week period. The standard deviation for the directorate as a

group was 37.60. The standard deviation for each individual employee, was 0.60.

3. Testing the Null Hypotheses for Inputs

a. Mean Staff Size

The null hypothesis for staff size (H_0: $X_1 = X_2$), that the staff size from before/after automation was statistically the same, was not confirmed at the .01 confidence level. Therefore, the alternative hypothesis, that the staff size before automation was larger than after automation was accepted. Staff size was found to be significantly smaller after automation. The t-test score for staff size was calculated at 2.821. This is outside the .01 confidence level.

Figure 2 presents a regression graph of the size of the Directorate of Contracting at Ft. Saxon, from both the pre-SACONS and post-SACONS periods. The pre-SACONS period represented on the graph, occured from Septemer 28, 1986 to November 7, 1987. This period represents Ft. Saxon before the Directorate of Contracting was automated with SACONS. Observe from the graph, that the number of employees on September 28, 1986 was 59, and that the number of employees grew over time. The vertical line on the graph represents the point in time when SACONS was installed.

The post-SACONS period of Figure 2 presents a regression graph of the size of the Directorate of Contracting, from November 8, 1987 to September 24, 1988.

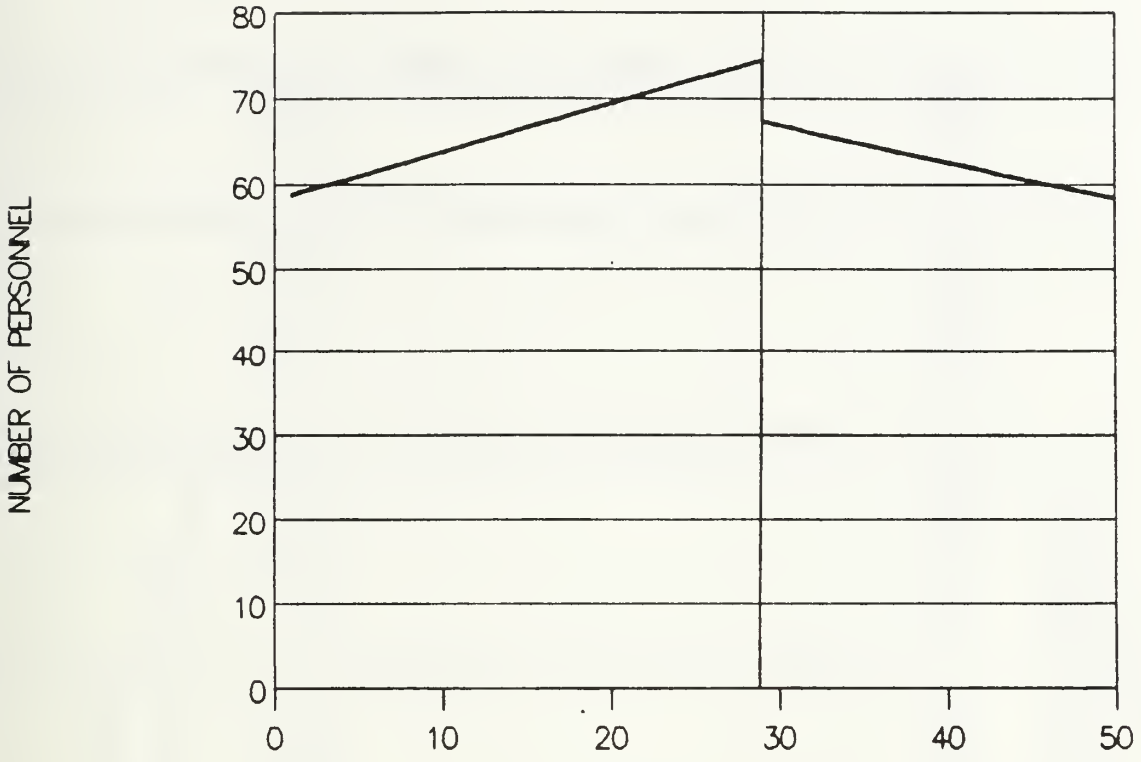

Figure 2. Staff Size Before and After SACONS

The graph of this period represents the Directorate of Contracting after the installation of SACONS. The number of employees was 67 at the beginning of the period and fell over time.

Tables III and IV show the number of employees in each division, per 2-week pay period. The far right hand column provides the average number of personnel of all five directorate departments, for the entire period. Table III

TABLE III

NUMBER OF EMPLOYEES
PER DIVISION, PRE-SACONS

DEPARTMENTS	PURCHASING	ADMINISTRATIVE SUPPORT	OFFICE OF DIRECTOR	CONTRACT ADMINISTRATION	CONTRACTING DIVISION	TOTAL PERSONNEL
DATES						
28SEP-11OCT 86	22	10	3	14	11	60
12OCT-25OCT	22	8	3	13	11	57
26OCT-08NOV	22	8	3	13	11	57
09NOV-22NOV	19	9	7	13	12	60
23NOV-06DEC	19	9	7	12	10	57
07DEC-20DEC	22	8	7	13	11	61
21DEC-03JAN 87	22	9	7	14	11	63
04JAN-17JAN	23	9	7	13	11	63
18JAN-31JAN	22	7	6	12	10	57
01FEB-14FEB	22	9	7	12	11	61
15FEB-28FEB	22	10	7	13	14	66
01MAR-14MAR	22	10	7	14	15	68
15MAR-28MAR	24	10	6	14	15	69
29MAR-11APR	24	13	6	14	12	69
12APR-25APR	23	13	6	14	12	68
26APR-09MAY	24	13	6	12	11	66
10MAY-23MAY	25	14	5	13	12	69
24MAY-06JUN	25	14	5	13	15	72
07JUN-20JUN	26	17	7	16	15	81
21JUN-04JUL	22	14	7	15	15	73
05JUL-18JUL	21	16	7	14	16	74
19JUL-01AUG	20	14	7	14	16	71
02AUG-15AUG	20	16	7	14	16	73
16AUG-29AUG	18	12	7	13	15	65
30AUG-12SEP	22	19	7	13	15	76
13SEP-27SEP	22	14	7	12	15	70
28SEP-10OCT	21	13	7	13	15	69
11OCT-24OCT	22	13	7	13	15	70
25OCT-07NOV	22	14	7	12	14	69
MEAN	22.07	11.90	6.28	13.28	13.17	66.69
STD. DEV.						6.11

TABLE IV

NUMBER OF EMPLOYEES
PER DIVISION, POST-SACONS

DEPARTMENTS	PURCHASING	ADMINISTRATIVE SUPPORT	OFFICE OF DIRECTOR	CONTRACT ADMINISTRATION	CONTRACTING DIVISION	TOTAL PERSONNEL
DATES						
08NOV-21NOV 87	23	11	7	13	15	69
22NOV-05DEC	25	10	7	12	13	67
06DEC-19DEC	25	10	7	12	13	67
20DEC-02JAN 88	26	10	7	12	14	69
03JAN-16JAN	24	12	7	12	14	69
17JAN-30JAN	23	9	7	12	14	65
31JAN-13FEB	21	9	7	12	14	63
14FEB-27FEB	21	9	7	12	14	63
28FEB-12MAR	22	9	7	12	14	64
13MAR-26MAR	23	6	7	12	13	61
27MAR-09APR	23	6	7	12	13	61
10APR-23APR	23	6	7	12	13	61
24APR-07MAY	23	6	7	12	13	61
08MAY-21MAY	23	6	7	12	13	61
22MAY-04JUN	23	6	7	12	13	61
05JUN-18JUN	23	6	7	11	13	60
19JUN-02JUL	23	6	6	12	13	60
02JUL-16JUL	23	6	6	12	13	60
17JUL-30JUL	23	6	7	11	13	60
31JUL-13AUG	23	6	7	12	13	61
14AUG-27AUG	21	7	6	11	13	58
28AUG-10SEP	23	6	6	11	13	59
11SEP-24SEP	23	7	8	11	13	62
MEAN	23.04	7.61	6.87	11.83	13.35	62.70
STD. DEV.						3.29

shows the pre-SACONS data and Table IV presents the post-SACONS data. The data as presented, indicate a clear drop in the number of employees required to staff the Directorate of Contracting after the SACONS installation.

b. Mean Grade Structure

The null hypothesis for the mean grade structure states that there is no difference in the populations between the before and after installation periods. It cannot be tested by Student's t-test because only one data point was observed in each of the before and after periods.

c. Mean Overtime

The null hypothesis that there is no difference in the before/after periods for the mean overtime used by the Directorate of Contracting as a whole, was also not confirmed. Again, the alternative hypothesis, that the two groups were different to a statistically significant degree, was accepted. The mean overtime hours used, was significantly less after automation. The t-score was 11.293.

The null hypothesis for the mean overtime worked per person per 2-week period, was likewise not confirmed. The alternative hypothesis, was accepted which says that the two groups are different. The t-score was 11.017. Again, the t-test used was one-tailed with direction predicted.

B. OUTPUTS

Measures of output were collected and evaluated in two ways;

- Volume of work, which represents the number of purchase requests processed per period, and
- Quality of work, which is represented by the Purchase Action Lead Time (PALT).

1. Before Automation

a. Mean Number of Purchase Requests

The mean number of purchase requests processed by the Directorate of Contracting at Ft. Saxon, before the installation of SACONS, was 2736.23 requisitions per month. The standard deviation was 1131.03.

b. Mean Purchase Action Lead Time

The purchase action lead time, was 31.52 days on average, needed to process each requisition. The standard deviation of the PALT was 33.67.[5]

2. After Automation

a. Mean Number of Purchase Requests

The average number of requisitions processed per month after the installation of SACONS was 2893.18. The standard deviation was 702.42.

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[5]The standard deviation is larger than the mean. This may seem unusual, yet the statistical test remains valid due to the large number of sample requisitions included in the t-test.

b. Mean Purchase Action Lead time

The PALT averaged 20.97 days after automation. The standard deviation was 28.85.[6]

3. Testing the Null Hypotheses for Outputs

a. Mean Number of Purchase Requests

The statistical significance for the before/after mean monthly volume of purchase requests, was not tested because the SACONS system did not affect the number of requisitions submitted to the Directorate in the short run. The number of requisitions submitted to the directorate was exogenous to the environment of the SACONS system.

b. Mean Purchase Action Lead Time

The null hypothesis, that there is no significant difference in the PALT before and after automation, was not confirmed. Therefore, the alternative hypothesis was accepted that the PALT was larger before automation. The t-score was calculated to be 4.987 for a one-tailed test with direction predicted.

Figure 3 illustrates the number of purchase requests processed from October 1, 1986 to September 30, 1988. The vertical line drawn at the thirteenth month of Figure 3, represents the installation of the SACONS system. Although the mean number of requisitions at 2893.18 was slightly higher after automation, than the mean total of

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[6]See note 5.

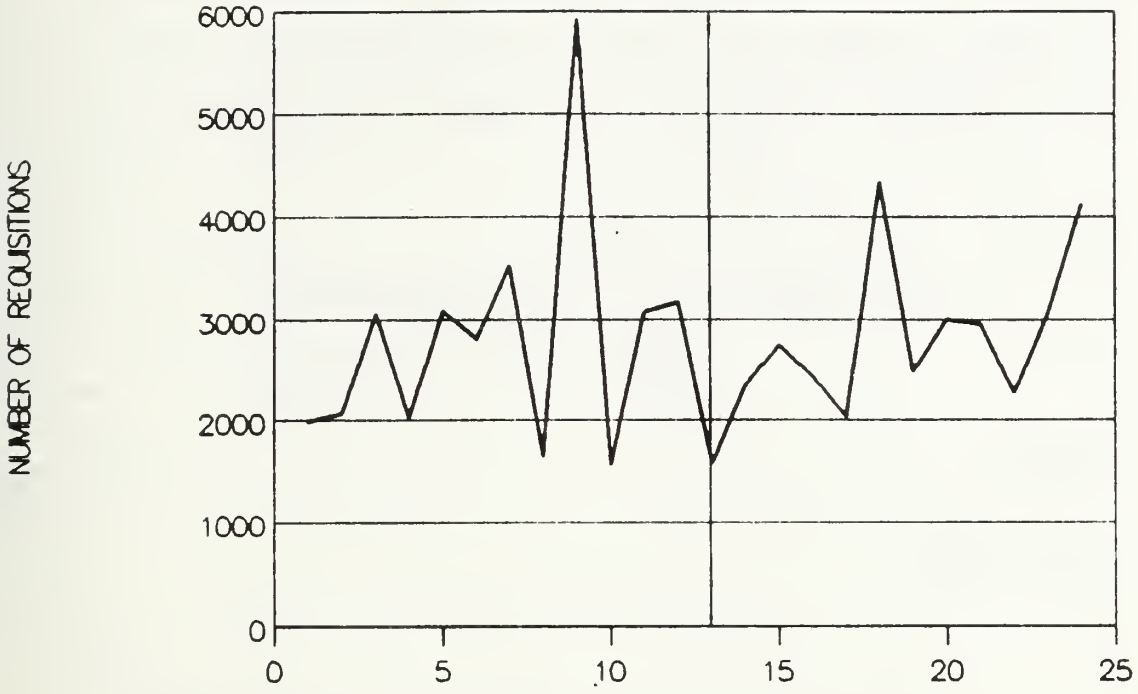

Figure 3. Number of Purchase Requests

2736.23 requisitions before automation, observe that there is tremendous variability in the number of requisitions over time. This variability of requisition submission is undoubtedly caused by the seasonal nature of the submission patterns by customers over the fiscal year.

Table V summarizes the changes in the procurement action lead time on a fiscal year basis. Observe from Table V, the average time to process requisitions at Ft. Saxon, dropped by approximately one

third after the introduction of SACONS. Moreover, the variability of the PALT measure as represented by the standard deviation dropped approximately 25 percent.

TABLE V

PROCUREMENT ACTION LEAD TIME SUMMARY

	Sample Mean	Standard Deviation
Manual Processing	31.52	33.67
Automated Processing	19.54	25.62

The PALT data were summarized on a monthly basis. This was done in order to evaluate the change in the PALT, over time. Figure 4 represents a regression graph of the average monthly PALT, from October 1, 1986 to September 30, 1988. The regression formula for the pre-SACONS period was $y = 35.75X - 0.768$. The pre-SACONS period occurred from October 1, 1986 to November 3, 1987. The post-SACONS period occurred from November 4, 1987 to September 30, 1988. Again, the vertical line at the mid-point of the graph represents the point in time at which SACONS was installed. The regression formula for the post-SACONS period was $y = 47X - 1.56$.

The pre-SACONS portion of Figure 4 illustrates a reduction of the PALT over time whereas the post-SACONS

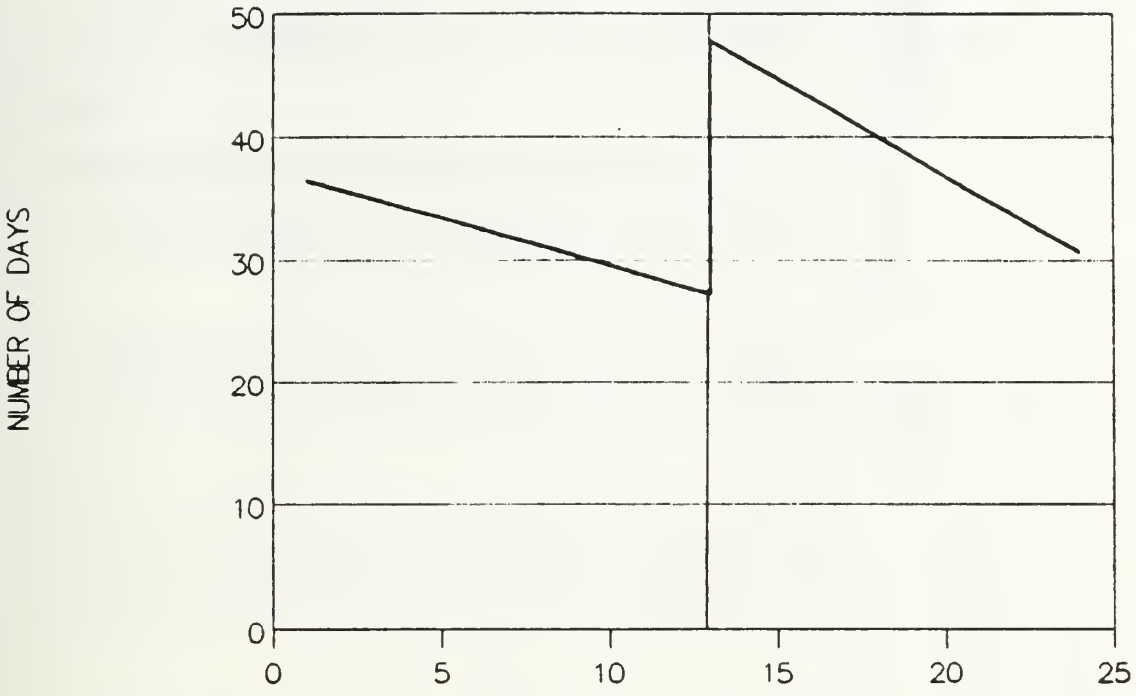

Figure 4. Mean Monthly PALT Before and After SACONS

portion of Figure 4 indicates a more precipitous drop in requisition processing time.

Table VI provides a summary of the monthly data from the entire two years of the study. The data were used to construct Figure 4. The PALT data are displayed in a month-by-month pattern.

TABLE VI

PROCUREMENT ACTION LEAD TIME
BY MONTH

MONTHLY STATISTICS	MAXIMUM VALUE	MINIMUM VALUE	RANGE	SAMPLE MEAN	VARIANCE	STANDARD DEVIATION
OCTOBER 1986	120.00	4.00	116.00	34.10	882.69	29.71
NOVEMBER	73.00	1.00	72.00	30.73	432.66	20.80
DECEMBER	88.00	13.00	75.00	42.20	331.89	18.22
JANUARY 1987	75.00	1.00	74.00	22.78	354.55	18.83
FEBRUARY	50.00	1.00	49.00	20.41	149.15	12.21
MARCH	204.00	1.00	203.00	45.49	3377.38	58.12
APRIL	185.00	2.00	183.00	39.94	2688.23	51.85
MAY	98.00	7.00	91.00	27.70	472.48	21.74
JUNE	113.00	1.00	112.00	38.50	1095.50	33.10
JULY	89.00	4.00	85.00	35.64	460.55	21.46
AUGUST	48.00	4.00	44.00	26.78	195.23	13.97
SEPTEMBER	95.00	1.00	94.00	20.00	574.50	23.97
OCTOBER	45.00	2.00	43.00	20.52	129.64	11.39
NOVEMBER	84.00	2.00	82.00	25.98	728.61	26.99
DECEMBER	93.00	1.00	92.00	20.49	626.55	25.03
JANUARY 1988	180.00	1.00	179.00	27.98	1052.36	32.44
FEBRUARY	170.00	1.00	169.00	20.20	1001.18	31.64
MARCH	115.00	1.00	114.00	17.00	422.84	20.56
APRIL	177.00	2.00	175.00	25.19	1528.63	39.10
MAY	145.00	1.00	144.00	34.80	1597.40	39.97
JUNE	90.00	1.00	89.00	15.30	392.75	19.82
JULY	72.00	1.00	71.00	11.03	180.19	13.42
AUGUST	45.00	1.00	44.00	14.43	156.09	12.49
SEPTEMBER	13.00	1.00	12.00	5.04	21.32	4.62

C. SOCIAL EFFECTS

1. Before Automation

Two measures were collected and evaluated as social effects resulting from the installation of the SACONS system. These measures were represented by the amount of annual leave and sick leave used.

a. Mean Annual Leave

The average monthly amount of annual leave taken by the Directorate of Contracting staff as a whole, before the installation of SACONS was 306.43 hours. The standard deviation was 47.39. In addition, the mean annual leave per person was 4.59 hours per pay period. The standard deviation was 0.71.

b. Mean Sick Leave

The amount of sick leave taken by employees of the directorate, as a group, was 249.48 hours per month. The standard deviation was 45.16. The mean sick leave per person was 3.74 hours, and the standard deviation was 0.68.

2. After Automation

a. Mean Annual Leave

After automation the amount of annual leave taken per 2-week period on average was 377.71 hours for the directorate as a group, with a standard deviation of 61.31. The mean annual leave per worker was 6.02 hours per period, and the standard deviation was 0.98.

b. Mean Sick Leave

The amount of sick leave taken by the directorate as a group, averaged 198.83 hours per pay period, while the standard deviation was 36.47. The average sick leave per person, was 3.17 hours per period, and the standard deviation was 0.58.

3. Testing the Null Hypothesis for Social Effects

a. Mean Annual Leave

The null hypothesis, that the mean monthly leave usage difference between the before-automation period and the after-automation period is not significantly different, was confirmed. The alternate hypothesis, that the leave used was greater before automation than after, was therefore rejected. The t-score for the change in annual leave as a group, was calculated to be -4.731. The t-score for the change in annual leave for each individual, was calculated to be -6.100.

b. Mean Sick Leave

The null hypothesis, that the mean monthly sick leave usage difference for the directorate as a whole, between the before-automation period, and the after-automation period, was not confirmed. The alternative hypothesis, that the usage of sick leave was greater before automation than after, was accepted. The sick leave t-score was 4.365. For the sick leave usage by individuals the null

hypothesis was not confirmed. The alternative hypothesis was accepted. The t-score was calculated to be 3.200.

Tables VII and VIII represent a summary of the total overtime worked, a measure of input, and the total annual

TABLE VII

OVERTIME, ANNUAL LEAVE, SICK LEAVE,
PRE-SACONS

DEPARTMENTS	ANNUAL LEAVE	SICK LEAVE	OVERTIME	NO. OF PERIODS	MEAN ANNUAL LEAVE	MEAN SICK LEAVE	MEAN OVERTIME
PURCHASING	2650.00	2144.00	1941.00	29	91.38	73.93	66.93
ADMIN SUPPORT	1394.00	1943.00	408.75	29	48.07	67.00	14.09
OFFICE OF DIRECTOR	551.00	483.00	312.00	29	19.00	16.66	10.76
CONTRACT ADMIN	2186.00	1704.00	1070.75	29	75.38	58.76	36.92
CONTRACTING DIVISION	2105.50	961.00	2679.00	29	72.60	33.14	92.38
MEAN TIME	8886.50	7235.00	6411.50		306.43	249.48	221.09

TABLE VII

OVERTIME, ANNUAL LEAVE, SICK LEAVE,
POST-SACONS

DEPARTMENTS	ANNUAL LEAVE	SICK LEAVE	OVERTIME	NO. OF PERIODS	MEAN ANNUAL LEAVE	MEAN SICK LEAVE	MEAN OVERTIME
PURCHASING	3003.00	1633.00	362.00	23	103.55	56.31	12.48
ADMIN SUPPORT	1174.00	413.00	16.00	23	40.48	14.24	0.55
OFFICE OF DIRECTOR	850.75	202.00	36.75	23	29.34	6.97	1.27
CONTRACT ADMIN	1934.50	1150.00	138.00	23	66.71	39.66	4.76
CONTRACTING DIVISION	1857.00	1175.00	257.50	23	64.03	40.52	8.88
MEAN TIME	8819.25	4573.00	810.25		304.11	157.69	27.94

and sick leave taken, a measure of social effect. All measures are listed by department and aggregated at the bottom of the tables. The mean annual leave taken is significantly different from the two periods. In addition, sick leave use is significantly less, after the installation of SACONS. Even more dramatically, the amount of mean overtime worked after the SACONS installation is reduced.

D. SUMMARY OF FINDINGS

A six-fold design table is included in Table IX to summarize the inputs, outputs, and social effects evaluated above.

TABLE IX

SUMMARY OF T-TEST RESULTS

	Before Automation	After Automation	t-test Results	
Inputs				
Mean Staff Size	66.69	62.70	2.821	p. < .01
Std. Dev.	6.11	3.29		
Mean Overtime per 2-week period	219.36	35.23	11.293	p. < .01
Std. Dev.	70.56	37.60		
Mean Overtime per worker per 2-weeks	3.29	0.56	11.017	p. < .01
Std. Dev.	1.06	0.60		
Outputs				
Mean Purchase Requests Processed	2736.23	2893.18	-0.399	p. < .01
Std. Dev.	1131.03	702.42		
PALT	31.52	20.97	4.987	p. < .01
Std. Dev.	33.67	28.85		
Social Effects				
Mean Annual Leave	306.43	377.71	-4.731	p. < .01
Std. Dev.	47.39	61.31		
Mean Annual Leave per worker per 2-weeks	4.59	6.02	-6.100	p. < .01
Std. Dev.	0.71	0.98		
Mean Sick Leave	249.48	198.83	4.365	p. < .01
Std. Dev.	45.16	36.47		
Mean Sick Leave per worker per 2-weeks	3.74	3.17	3.200	p. < .01
Std. Dev.	0.68	0.58		

V. ANALYSIS AND CONCLUSIONS

A. INPUTS

1. Staff Size

Before automation at Ft. Saxon, the number of people required to staff the Directorate of Contracting (DOC) averaged 66.69. After the installation of SACONS, the number of people staffing the Directorate declined to 62.70. This represents a drop in manpower requirements of 5.98 percent and an increase in productivity. The Directorate can do its work with 5.98 percent fewer people after automation. In that productivity is defined as the quantity of outputs divided by inputs, then reducing staff size (a measure of input), ceteris paribus, effectively increases productivity.

2. Grade Structure

The average GS grade in the DOC before automation was 5.985. After automation it was 7.212. This represents a 20.5 percent increase. An increase in average grade structure is effectively an increase in an input cost. In describing the productivity ratio as outputs divided by inputs, increasing input costs, ceteris paribus, was counter productive.

However, it was ascertained from interviews with DOC supervisory personnel, that the new director began a program

to raise the GS level of Directorate employees upon taking command. His program to increase the GS level of the employees was independent of the installation of SACONS.[7]

Raising the GS pay level of Directorate employees however, won support for automation. Although raising the GS level of Directorate employees resulted in higher morale, it represents a counter-productivity outcome.

3. Overtime

The amount of overtime used by the Directorate before automation was 3.29 hours per worker during each 2-week pay period. The amount of overtime used after the installation of SACONS was 0.56 hours per worker, per pay period. The use of overtime declined 82.98 percent. This finding represents an increase in productivity by virtue of a decrease in inputs.

While some payroll costs were reduced, others were increased. In order to derive the net effect of the changes in various costs, we have calculated the cost of the payroll at DOC, before and after the installation of SACONS. This analysis was done by multiplying the number of employees at each GS pay level by the GS pay rate. We then summed all individual pay totals to arrive at a total payroll figure for the before and after-SACONS periods.

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[7]The decision to write job descriptions of DOC employees at a higher grade level was made in order to reflect the true complexity of the jobs being performed. This was done in accordance with the higher GS levels allowed by Civilian Personnel Office regulations, as revised in 1983.

Before automation, DOC faced backlogs in the processing of requisitions. After automation, the productivity of SACONS reduced the backlogs. When SACONS removed the bottleneck of requisitions awaiting processing, the need for overtime was reduced.

B. OUTPUTS

1. Purchase Request Volume

The number of purchase requests, before automation, averaged 2736.23 per month. After automation the number of purchase requests averaged 2893.18 per month. The number of requests rose 5.74 percent per month. The number of purchase requests is exogenous to the presence of SACONS.[8] While the number of requisitions before/after SACONS was not statistically tested, it must be pointed out that were all other measures held constant, an increase in the number of requisitions processed constitutes an increase in productivity. The volume of requests shows that other results in this study could not be laid to a decline in DOC workload.

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[8]Purchase request volume was not subject to hypothesis testing because in the short run SACONS productivity does not affect demand. In the long run however demand goes up as shadow requisitions are submitted, e.g., the Directorate begins to look for more work, such as inventory management for large customers, and customers begin to submit more requisitions simply because the requisition process works more efficiently.

2. Procurement Action Lead Time

The time required to process a requisition, a measure of the quality of DOC service to user facilities, averaged 31.52 days before automation. After the installation of SACONS the time required was 20.97 days. Procurement Action Lead Time fell by 33.47 percent after automation. Raising the quality of outputs, ceteris paribus, constitutes an increase in productivity occurring after the installation of SACONS.

Figure 5 presents the relationship of inputs and outputs both from the before/after SACONS period.

	Pre-SACONS	Post-SACONS
Input	Higher	Lower
Output	Lower	Higher

Figure 5. Productivity Matrix

C. COST RECOVERY PERIOD

One method to evaluate capital improvements is the use of the concept of cost recovery. Cost recovery is an economic method that attempts to quantify the costs of a capital project and subsequently to determine the period of time needed to recover those costs due to efficiencies resulting from the capital improvement project. This study does not present a cost recovery analysis. However, a look at the project in cost recovery terms is of value.

The capital cost of the SACONS system was given as $500,000. This includes the total cost for the purchase and installation of the hardware, software, and the maintenance contract. Figures obtained from the Directorate indicate an annual savings of $42,000 in lower overtime costs, and $8,000 in a lower use of paper and other miscellaneous costs. In addition, the pre-SACONS payroll was calculated at $1,345,881 per year. The post-SACONS payroll totaled $1,167,701.[9] The difference in the before and after SACONS periods results in a direct payroll cost savings of $178,180 per year. All cost savings (direct payroll, overtime, and miscellaneous costs) combine to indicate a cost recovery period, for recovery of capital investment, of about 2.19 years.

D. SURROGATE INDICATORS OF SOCIAL EFFECTS

While documenting the productivity resulting from the automation of the purchasing function in DOC, we were impressed by anecdotes remarking upon the social/psychological by-products of the SACONS installation. Rather than merely pass along these impressionistic accounts, we sought to establish some quantitative evidence of changes in available archival data.

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[9]See Appendix F.

We were able to gather comparative before/after data on three measures that are surrogate indicators of the social/psychological impact of automation:

- Usage of sick leave,
- Usage of annual leave,
- Group cohesiveness and professionalism.

1. Sick Leave

The use of sick leave fell 15.24 percent after the installation of SACONS. This implies increased job satisfaction. Moreover, a reduction in sick leave usage reflects a reduction in input costs. This, ceteris paribus, constitutes an increase in productivity.

Sick leave has been a traditional safety valve for relief from stress and job demands. The sick leave policy provides an avenue for a dissatisfied or stressed employee to escape the demands of his work environment. First, sick leave is earned by an employee and the decision to use it is made solely by him or her, independent of management control. Second, no documentation is needed from a physician to verify an employee's sickness. Therefore, sick leave is a ready resort whenever workload and stress is high. It is assumed that the environment created by the use of SACONS is less stressful and is responsible for the decrease in the use of sick leave.

It should be noted that sick leave can be accumulated by federal employees and applied for retirement

credit. This provides the employee with a reason to save sick leave. It does not however, dilute the argument that the post-SACONS period was less stressful than the pre-SACONS period. The motivation to save leave for retirement credit is the same regardless of the installation of SACONS.

2. Annual Leave

In contrast to the decline in the use of sick leave, the use of annual leave increased 31.52 percent. We do not view this finding as an indicator of a decrease in productivity brought on by the installation of SACONS.

Federal leave policy encourages employees to take all earned leave. Generally the use of leave is subject to management control. Management decides if the workload is such that leave can be granted without being detrimental to the organization. Before the installation of SACONS, the Directorate's backlogs, caused an increase in overtime and prevented the granting of annual leave. After SACONS was installed, backlogs disappeared and there were opportunities to use the accumulated leave that would be lost if not taken. Therefore, we assert that the increased use of annual leave is not an indicator of job unhappiness. It is a combination of bottled up leave and the opportunity to take leave as a result of the disappearance of backlogs.

3. Group Cohesiveness and Professionalism

Interviews with the Directorate supervisors revealed that group cohesiveness and professionalism has increased as

a result of SACONS. Much of the credit can be given to the less stressful office environment created by the elimination of frequent backlogs and overtime experienced before the installation of SACONS. The following are some of the improvements that the supervisors noted:

- Before SACONS there was an "us/them" struggle between the typists and buyers. Each accused the other of being slow, making too many errors, and of losing purchase requests. After SACONS, there was little need for typists as each buyer entered the data for their assigned purchase requests.

- Before SACONS, supervisors did not have an accurate account of the number of purchase requests that an employee had, the status of the requests, or the complexity of the request. After SACONS, supervisors were able to call up the status of each employee's workload, monitor their progress, identify problems and redistribute workloads.

- As a result of SACONS, employees have access to information on the entire history and current status of their own workload. In addition, an employee can access the status of other employees workloads for comparison purposes.

- The Directorate uses a team leader concept of management. There are three teams with approximately seven employees in each team. The team leaders help the supervisor monitor the workloads of each employee. Prior to SACONS, the team leader concept was not feasible.

- Using SACONS, employees are able to keep up with their workload. Therefore, they now have more time to help each other and for group training by the supervisors.

- Better communication was developed by virtue of the fact that all employees were learning together to use SACONS. This learning environment allowed them to freely ask questions among themselves and solicit individual help. Also, friendly competition developed between employees as they learned more about SACONS.

- The employees pride in craftsmanship developed. Since SACONS eliminated the need for typists, buyers are now

responsible for their purchase requests almost from start to finish.

All of these factors aided in the increase in unit cohesiveness, professionalism, and self worth. Workers now have more control over their workload and their time. Less time and effort is spent on finding misplaced documents and placing blame.

E. COMPARISON OF FINDINGS AND METHODS WITH LITERATURE REVIEW

Our study encompasses many aspects of the current literature on productivity measurement. Although there is not one specific study found in our literature search that echoes ours, portions of a number of studies and their methods can be compared.

Our study used the industrial engineering definition of productivity as a ratio of output to input. The inputs were the number of people, their grade structure and the amount of overtime used. The outputs were the number of purchase requests processed and the time required to process a requisition. These multifactor measures fit Christopher's (1986) criteria of being countable and descriptive of what an organization does to achieve its goals.

Although briefly addressed in our literature review, it is interesting to note that our study touches on two additional measures of productivity: reductions in head count and cost recovery. We have shown that the installation of SACONS has contributed to a six percent

decrease in personnel and that the system will pay for itself in just over two years of operation.

Through our study we have also discovered that we are in agreement with those, such as Weatherbe (1987), who assert that job satisfaction is a key indicator of productivity. Surrogate indicators of productivity, such as the usage of sick leave, provide insight into job satisfaction in this case.

Overall, we found in this case that office automation was not seen as a technological threat. Faerstein characterizes employees' reactions to computerization in such terms as "computerphobia," "technophobia" and "technostress." None of these "illnesses" were seen at the Directorate. Further, there was no indication of many of the fears that Faerstein says may lead to anxiety and create difficulties in an automated office such as: resistance to change, fear of becoming de-skilled, or fear of isolation or alienation from the rest of the office.

F. ACCOMPLISHMENTS OF THE STUDY

We employed a quasi-experimental research design that gathered archival indicators of inputs, outputs, and social effects before and after the automation of office processes in a single organization. The study of the effects of the installation of SACONS has established an empirical bench mark for office automation productivity. This was accomplished using a classical industrial engineering

Input/Output model of productivity. In addition, we looked at organizational behavior issues.

In this study, we discovered a beneficial impact of office automation on small group dynamics and individual psychology. We captured empirical evidence of the social impact of SACONS from archival data rather than with the use of an opinion survey.

G. SUMMARY OF SACONS BENEFITS

The SACONS system in use at Ft. Saxon was found to enhance productivity. Productivity was enhanced in a variety of ways:

- The system controls the worker and the work environment. Each purchase request can be easily called up and traced by both worker and supervisor. In addition, a user can view a performance scoreboard that can be used to judge employee progress and to redistribute workloads according to experience and capabilities.

- There is no hiding of difficult purchase requisitions. In the past, difficult requisitions were set aside for weeks at a time, until a worker felt he or she could give them proper attention.

- SACONS cuts down on lost time such as the time spent going from desk to desk trying to locate purchase requests. This allows more time to be spent on the primary activities of the Directorate.

- As a result of SACONS, work has become less trivial and involves less drudgery. Because a worker is now accountable for the completion of a purchase requisition from start to finish, each effort is considered important. Hence self-worth and professionalism increased.

- Employees like having instant access to their own performance record. This enables an employee to monitor his or her own progress. An employee can also see a clear connection of individual effort with results.

- The finished product, a completed DD 1155, is a sharp, professional looking document. This too, increases worker pride and self worth.

H. DIRECTIONS FOR FURTHER RESEARCH

Much has been accomplished in the year since SACONS was installed at Ft. Saxon. The following questions need to be answered for the productivity story to be complete.

- It remains to be seen if reasonable goals and expectations have been set regarding the long term productivity of the Directorate of Contracting under the SACONS system?

- A survey supplement on change in attitudes among workers is needed to bolster archival findings. This is underway.

- Undoubtedly, the strong leadership in the Directorate contributed to the success of SACONS. Further study must look at the role of leadership in achieving the productivity increase we observed. How powerful is the SACONS system in improving productivity when management is not supportive? To what degree is the productivity of the system dependent on the office climate created by management? A comparative study in another setting is underway.

- A long run re-study of SACONS productivity at Ft. Saxon is needed. When will the productivity curve level off? At what level will further improvement fail to materialize?

- A study is needed that will take a long run look at the increased demands put on the SACONS system, due to its very productivity.

- A comparative study of the productivity of a tight-control SACONS system with the productivity of a loose-control system such as a word processing operation is needed.

- It will be interesting to note any increased applications of SACONS in the future and their affects on productivity. Already the Directorate is looking to extend SACONS uses to other organizations at Ft. Saxon. They are currently installing a modem hook-up so that certain user activities, such as the Supply Department

and the Directorate of Engineering and Housing, can access the status of their open requests.

Finally, and perhaps of paramount importance a further productivity study is needed that uses archival data within the framework of the experimental design as was done here. Otherwise, the productivity of office automation cannot be established with the rigor of scientific disproof.

APPENDIX A

SACONS MAJOR HARDWARE REQUIREMENTS

1. 8 Intel Corporation Model 310's,
2. 7 Intel Corporation Model 311's,
3. 1 Intel Corporation Modle 310AP,
4. 1 Intel Corporation Model 320,
5. 9 Intel Corporation Console Terminals,
6. 74 Intel Corporation User Terminals,
7. 1 Intel Corporation 9-Track Tape Drive,
8. 1 Intel Corporation 3500 Printer,
9. 3 Intel Corporation F10-55 Printers,
10. 5 Intel Corporation Laser Printers,
11. 2 Intel Corporation 300Q Printers,
12. 1 Intel Corporation Plotter,
13. 148 Intel Corporation Modems (local),
14. 1 Intel Corporation Modem (telephone).

APPENDIX B

REQUISITION PROCESSING AT FT. SAXON

A. MANUAL REQUISITION PROCESSING

The following describes in general the document flow.

Requisitions are received in the mail room at the Directorate of Contracting and date stamped to begin the PALT period. At this point, requisitions are evaluated in order to determine if the material requested is available from standard stock, or must be purchased on the open market. If the requested material is available from standard stock, a document is prepared to request the material from the integrated supply system.[10]

If the material requested cannot be provided from standard stock, the requisition is entered into an IBM System 34 for the generation of the buyer's worksheet. The IBM System 34 provides no capability for enabling research evaluation or report generation, and no correction capability.

Worksheets are printed from the IBM System 34 in bulk, matched with the purchase requests and sent to the purchasing agent for appropriate action. A file is opened by the purchasing agent. If multiple requisitions are

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[10]The Integrated Supply System represents material that is owned by the General Services Administration (GSA), the Defense Logistics Agency (DLA), or the individual military services.

received from a customer they may be grouped together for purchase, if the material or services requested are similar, or the award can be made to one vendor. This frequently results in multiple requisitions per folder. The requisitions are assigned to a purchasing agent generally on the basis of type of material requested.

The purchasing agent attempts to place the order with a vendor. On many occasions the buyer may place an order directly with a vendor through the buyer's prior knowledge of the marketplace. If the buyer is unfamiliar with an item or the dollar value of the buy is above $2500, the requisition must be bid competitively. If a requisition is bid competitively, certain purchasing requirements, as set by the Federal government, must be met. These include requirements concerning where to advertise the buy and for how long. During the awarding of the requisition, a buyer is required to record specific information on the preprinted worksheet as previously generated by the IBM System 34.

After a requisition has been awarded, either through competition or not, a contract must be prepared. A contract is prepared on the DD Form 1155. The work of the contracting division essentially is to prepare the contract to include the terms of the award. This involves choosing the appropriate clauses to place within the contract.

After the DD Form 1155 has been prepared by the contract specialists, it is returned to the purchasing agent for

verification and proofreading. Initial preparation of the DD Form 1155 or any correction thereof is by the use of a typewriter.

At the last step of the process, the DD Form 1155 is submitted to the contracting officer for approval.

B. AUTOMATED REQUISITION PROCESSING

The essential changes to the document preparation process under the SACONS program are;

- Documents are not physically moved from the purchasing division to the contracting division and back to the purchasing division. This is because a data base is maintained that provides all authorized users access to the requisitioning information via a terminal that accesses the SACONS system.

- Errors or adjustments to the DD Form 1155's can be made to the file in the computer memory.

- Requisitions can be monitored for the status of the buy at any time during the process.

- Workloads of the purchasing agents can be electronically adjusted in response to emerging requirements at any time.

- Management information is available to supervisors, allowing for the correct matching of resources to workload requirements.

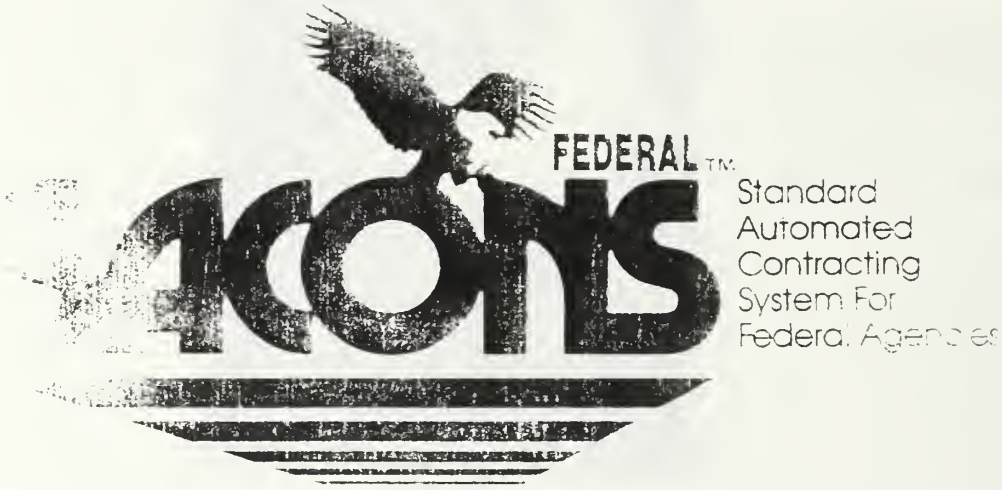
APPENDIX C

SACONS DESCRIPTION

The description of SACONS that follows has been provided by CACI Inc. It has been reproduced from a brochure produced by the company, and is intended to give interested readers additional information about SACONS.

The one
computer system
in this world
that revolutionizes
your approach
to contracting

FEDERAL SACONS
Standard
Automated
Contracting
System For
Federal Agencies


FEDERAL™
ICONS
Standard
Automated
Contracting
System For
Federal Agencies

You'll be amazed at how productive your procurement office can be

Productivity and job satisfaction go hand in hand

How do you transform the complex world of procurement into a place where work can be done easily and efficiently? Let us provide you with the right tool and a place to start.

SACONS-FEDERAL™ . . . Improve your productivity and simplify your work processes using the most comprehensive automated contracting system available today.

SACONS-FEDERAL™ . . . Enhance your procurement process from purchase request entry through award close-out. It is completely adaptable to a variety of system hardware configurations and can function on single-user PCs as well as multi-user local area networks.

SACONS-FEDERAL™ . . . Experience the very best in automated information systems technology. Whether you're currently working in a manual or automated environment, you can streamline your operation and improve the way you do business. User-friendly design makes it easy to learn and simple to use.

Access to key information lets you make your best management decisions

Ensuring the smooth, uninterrupted flow of work is difficult when there are constant demands on your time. That's where SACONS-FEDERAL's™ user friendly management reporting features can help.

Status and Performance

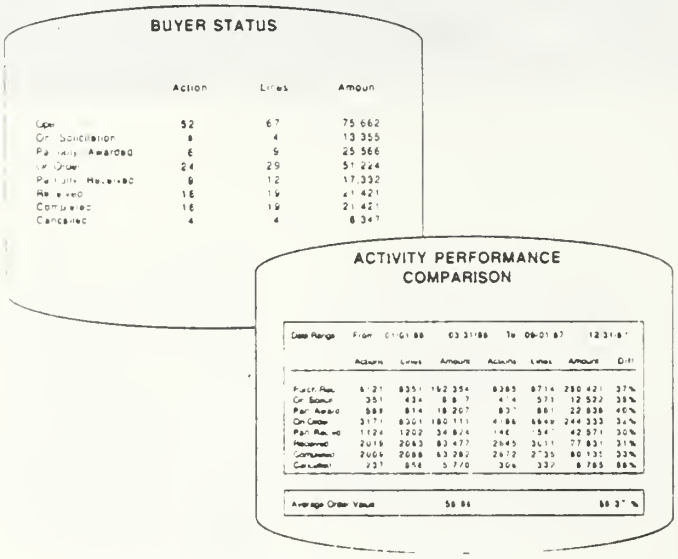
How many requisitions are in-house? What is their status? How many line items are involved?

Imagine having all this information now — not days from now — and without wasting valuable time and resources manually collecting the data. Just a few keystrokes can immediately tell you what you need to know.

Status reports measure your volume of work by purchase request status for your entire office or for a specific buyer. You can even generate performance reports to compare the volume of work for two different work periods.

Procurement Administrative Lead Time (PALT)

Knowing your PALT is an important asset for any procurement office. SACONS-FEDERAL™ gives you the flexibility to further define this vital information by enabling you to assess PALT by purchase order, delivery order, contract, or by combining all order types — all at the touch of a button.



Status and performance reports provide information on an individual buyer or an entire activity

Get a Variety of Reports

Does your staff get calls from impatient customers wanting information on a particular order? The Procurement Action Status report gives the status of each purchase request currently in process.

All levels of management and staff can get this and much more information through such tools as the Purchase Request Register, Award Register, Receiving, Vendor, and Stock Item reports.

Ad-Hoc Queries

Being aware of your activity's current status, performance, and administrative lead time alone would give you the edge, but SACONS-FEDERAL™ gives you many more extras, such as an ad-hoc feature that provides you with the option to custom-design your own reports.

Were you ever asked how many dollars you spent in your city? Using the English language ad-hoc capability, you can answer this question in minutes instead of days. What type of information do you want? Put your imagination to work and let SACONS-FEDERAL™ deliver the product!

SACONS-FEDERAL™ takes much of the guesswork out of managing by providing automated features that allow you to make important decisions quickly and easily

MANAGEMENT BENEFITS

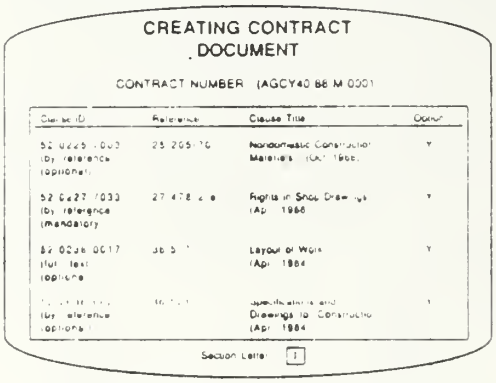
- *Increased operational efficiency across the board*
- *Reduced procurement administrative lead time*
- *Significant savings in operating expenses*
- *Sizable reductions in personnel overtime*
- *Access to complete status and performance information*
- *Unlimited reporting flexibility using the ad-hoc reporting feature*
- *Decreased filing requirements*

Contract specialists now have direct access to resources they really need

SACONS-FEDERAL™ supports the contract specialist through the entire solicitation and award processes. Contract specialists produce laser-drawn RFQs, IFBs, and RFPs. They combine line item information already stored in the system with any comments and additional clauses. Additonal specifications may be included in the final solicitation document.

Acquisition Regulations Research

It's easy to perform on-line research of Federal Acquisition Regulations and Supplements by using a menu to access the text of all your regulations. The specialist decides what to use and SACONS-FEDERAL™ searches by regulation number or keyword



System selected clauses are evaluated to determine their appropriateness to the document

Milestone Tracking

A variety of electronic checklists is available to assist personnel in tracking solicitation and award information. Contract specialists use these checklists to organize their workloads, maintain the required document control, and track important procurement actions and dates.

Automated Document Preparation

Using only a few simple screens, the system automatically compiles and displays the requested data. By accessing and selecting stored information, the contract specialist can easily create and manage sections of the Uniform Contract format.

On-line acquisition regulations, clauses, and provisions are grouped by user specifications and can be easily selected from a menu. By hitting a single key, the contract specialist can view the selected clause text on the screen, include the clause in the document, enter any necessary fill-in data, and select the document section in which to print the clause.

Bidder's Mailing List

The automatic vendor rotation feature, based on federal supply classifications, ensures that all vendors in the file have opportunities to bid Prospective vendors are rotated in accordance with Federal Acquisition Regulations (FAR) standards and the option to add or delete vendors on the mailing list is always available.

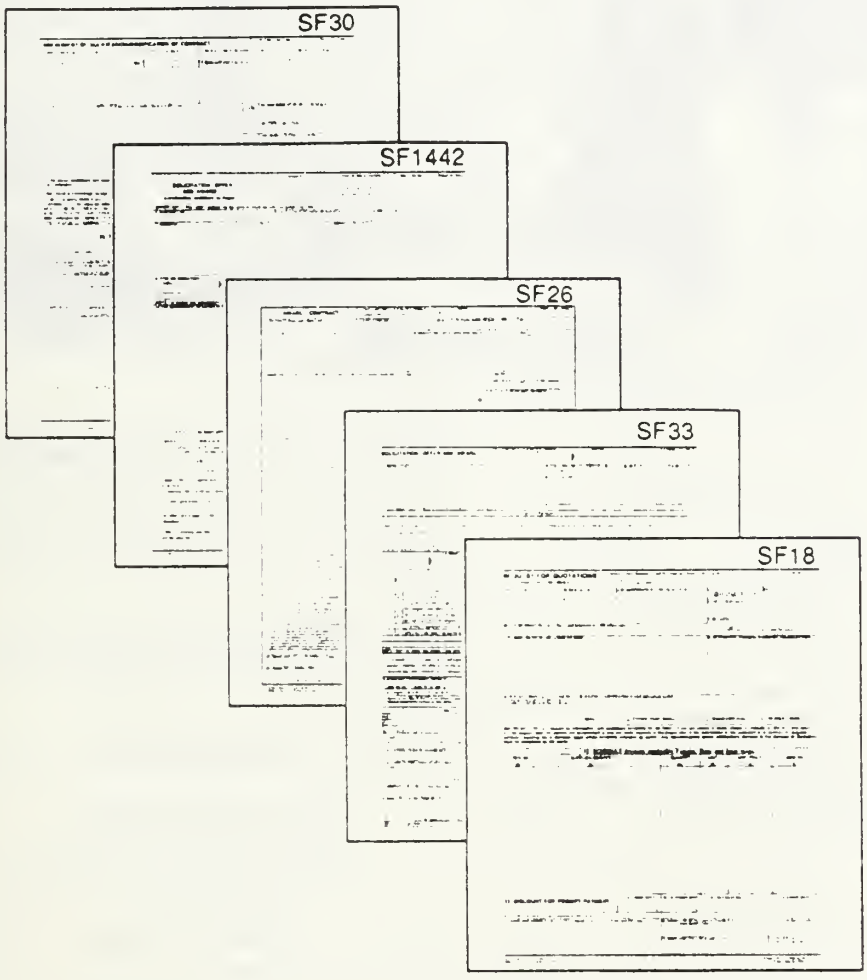
For a particular requirement, there's no need to research past mailing lists, solicitations, or awards for prospective vendors. After selecting the desired number of bidders, SACONS-FEDERAL™ automatically generates a mailing list of those vendors in the system who may supply the items.

Bid Abstract

The bid abstract feature allows buyers to record bids for each line item. Buyers always have the option to add new bidders.

Letter-Quality Forms

SACONS-FEDERAL™ automatically generates all government forms using a laser printer, which produces clear, original-quality documents. All standard forms are recreated exactly like the forms produced by the Government Printing Office.



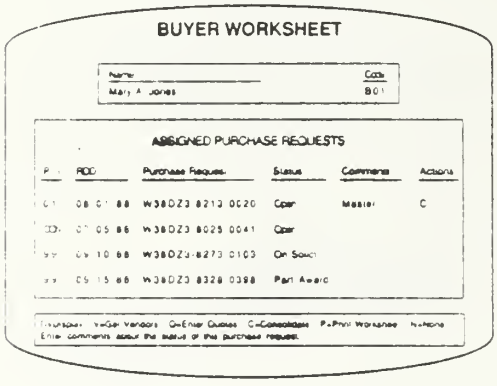
Original-quality government standard forms are automatically produced on a laser printer

Electronic worksheets help buyers do what they do best

How do you efficiently manage large volumes of work? SACONS-FEDERAL™ helps the process by giving buyers on-line access to their workloads through electronic worksheets. These worksheets help prioritize workloads so that buyers can most effectively perform their procurement functions.

Workload Processing

Because worksheets are arranged in a clear, concise format, they provide buyers with a vital tool for controlling and organizing their workloads. Assigned requisitions are displayed on individual buyer worksheets by priority. Buyers can easily view a specific purchase request and its line items or print a hard copy of the request and its line items to determine what actions to take to process the request.



Worksheets help buyers prioritize their workloads

Purchase Request Consolidation

The consolidation feature offers the convenience of combining an unlimited number of purchase requests to help buyers simplify their workloads while obtaining maximum discounts. The system searches for consolidation candidates and lists them, one at a time, prompting for the buyer's decision to consolidate. Running consolidated values are displayed to aid the buyer in determining whether or not to consolidate.

Vendor Candidate Selection

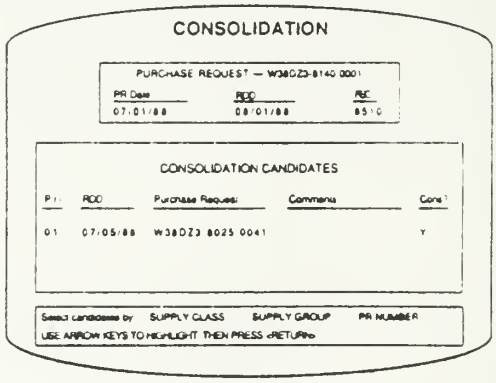
Buyers have two options for selecting vendor candidates. The first option searches the vendor file and selects three candidates who can supply the requirements. A fourth candidate slot is always open to give buyers the option to manually select a candidate. The second option allows the buyer to select all four candidates.

The automatic vendor rotation feature, based on federal supply classifications and established in accordance with FAR standards, ensures that all vendors in the file have opportunities to bid.

Quote Evaluation and Award

Quotes obtained from an RFQ or oral solicitation are entered on-line through the worksheet process. As each requested line item appears, the buyer enters the quote information. A spreadsheet, listing all the bidders and their line item quotes is printed.

Once a vendor is selected, a complete order package is generated on laser-drawn government forms.



The consolidation feature enables buyers to easily combine purchase requests for more efficient ordering

SACONS-FEDERAL™ is designed with buyers and contract specialists in mind
It gives them the tools to do what they do best — make buying decisions

SMALL PURCHASING FEATURES

- *Electronic worksheets*
- *Single keystroke processing for fast and efficient access to information*
- *Ability to consolidate purchase requests*
- *Automatic vendor selection*
- *Manual vendor entry option*
- *Ease in entering quotes*
- *Laser drawn purchase orders — DD1155/SF347*

Our quality system design and customer support assures user satisfaction

Leading Edge Technology

SACONS-FEDERAL™ is designed and developed using the very latest in Fourth-Generation Language/ Relational DataBase Management System technology. To the end user, this means high productivity, short product enhancement cycles, and consistently high standards of quality.

On-Line Help

User-friendly system design means that on-line help is always there. Functional-level help is available at the touch of a key and field-level help is provided in the form of edit messages at each field entry. In addition, the system displays error messages if incorrect data are entered and the user is given the opportunity to enter the correct data.

Security at Every Function Level

The SACONS-FEDERAL™ system offers a variety of security options. Access can be limited at the menu level, the subfunction level, or can be customized to limit access at the individual field level. Security settings can be reset at any time and the changes are effective immediately, thus safeguarding system integrity.

Customer support makes the difference!

Full Customer Support

At CACI, we realize that the acquisition of computer software is just the beginning. Successful automation of your contracting office will require the kind of support you get from only the best customer service organization.

At CACI, we have over 55 people dedicated to the support of our already installed automated contracting systems.

Our Washington, D.C. area offices feature a full service customer support center. This custom designed facility includes a classroom with an adjoining computer room containing the hardware used by our customer organizations.

Complete User Documentation

Our manuals are written with the user in mind. Simple, clear, easy to follow instructions combined with state of the art graphics make our documentation easy for everyone to use.

User Training

Our experienced team of professional trainers can accommodate any or all of your training needs. We can provide any level of training from standard classroom training to tailored training designed to meet your particular requirements. Training can be provided at our facility or yours.

Technical Support HOTLINE

Experienced hardware, software and training personnel are on call to support you and your organization on all aspects of SACONS-FEDERAL™. The HOTLINE is open from Monday to Friday between the hours of 8:00 A.M. and 5:00 P.M., EST.

Federal Acquisition Regulations Update Subscription Service

A complete subscription service for the FAR and all its Supplements is available to users. Updates are released as required to holders of this subscription service.

CACI is a high technology and professional services corporation. Founded in 1962, CACI is a leader in advanced information systems, systems engineering, logistics sciences, proprietary analytical software products, and market analysis consultancy services, information products, and systems.

CACI's defense support technology draws upon its leading edge in computer system design and complex turnkey integration applications that include on-line software and database systems as well as simulation and modeling.

We're the Experts in Procurement Automation

CACI employs technical experts who deliver quality products and services to our customers. Combining our expertise in computer systems design and development with our extensive experience in the procurement field has enabled us to develop the very best in automated procurement systems.

For more information on SACONS-FEDERAL™, contact Systems Management Division - D1411

CACI
8260 Willow Oaks Corporate Drive
Fairfax, Virginia 22031

(703) 876-2060
Automatic Telecopy Number (703) 876-2224

At CACI, We're Committed to Excellence.

APPENDIX D

SUMMARY OF MONTHLY PROCUREMENT ACTIONS

MONTH	DATE	# ACTIONS	$ VALUE
1	OCT 30 1988	1,992	$2,595,476
2	NOV 30 1986	2,075	1,786,658
3	DEC 30 1986	3,066	2,087,028
4	JAN 30 1987	2,031	1,664,620
5	FEB 28 1987	3,089	2,010,824
6	MAR 30 1987	2,808	2,061,870
7	APR 30 1987	3,529	2,830,229
8	MAY 30 1987	1,654	1,458,343
9	JUN 30 1987	5,918	4,288,039
10	JUL 30 1987	1,578	1,686,393
11	AUG 30 1987	3,076	2,354,847
12	SEP 30 1987	3,173	3,190,125
13	OCT 30 1987	1,582	2,809,279
14	NOV 30 1987	2,362	1,560,496
15	DEC 30 1987	2,749	1,750,913
16	JAN 30 1988	2,433	1,803,334
17	FEB 28 1988	2,040	1,987,419
18	MAR 30 1988	4,342	2,645,508
19	APR 30 1988	2,492	2,008,665
20	MAY 30 1988	3,002	1,730,058
21	JUN 30 1988	2,961	2,437,108
22	JUL 30 1988	2,273	1,575,405
23	AUG 30 1988	3,054	1,988,095
24	SEP 30 1988	4,117	5,471,881
BEFORE SACONS	SUMMATION	35,571	30,823,733
	MEAN	2736.23	2,371,056
	St Dev	1131.03	
AFTER SACONS	SUMMATION	31,825	24,958,882
	MEAN	2893.18	2,268,989
	St Dev	702.42	
TOTAL	SUMMATION	67,396	55,782,615
	MEAN	2808.17	2,324,276
	St Dev	961.86	

APPENDIX E

FT. SAXONS ORGANIZATION CHART

Officer in Charge

BEFORE SACONS	AFTER SACONS
Office of the Director	
1 GS12 Supervisor	1 GS12 Supervisor
1 GS06 Secretary	1 GS12 Cost Price Analyst
	1 GS06 Secretary
Administrative Support Division	
1 GS07 Supervisor	1 GS09 Supervisor
1 GS06 Management Assistant	1 GS07 Management Assistant
1 GS05 Lead Processing Clerk	1 GS05 Lead Processing Clerk
2 GS04 Processing Clerks	1 GS04 Imprest Fund Cashier
6 GS03 Processing Clerks	3 GS03 Processing Clerks
5 GS03 Clerk Typists	
1 GS03 Mail and File Clerk	
Contracting Division	
1 GS12 Supervisor	1 GS11 Supervisor
2 GS11 Contract Specialists	3 GS11 Contract Specialists
2 GS09 Contract Specialists	4 GS09 Contract Specialists
4 GS07 Contract Specialists	3 GS07 Contract Specialists
2 GS05 Contract Specialists	1 GS05 Contract Specialist
2 GS05 Procurement Clerks	
1 GS04 Procurement Clerk	
1 GS03 Procurement Clerk	
Contract Administration Division	
1 GS12 Supervisor	1 GS12 Supervisor
1 GS11 Contract Admin	3 GS11 Contract Administrators
5 GS09 Contract Admin	1 GS09 Contract Administrator
1 GS07 Contract Admin	3 GS07 Contract Administrators
2 GS05 Contract Admin	2 GS05 Contract Administrators
2 GS05 Procurement Clerks	
1 GS03 Clerk Typist	
Purchasing Division	
1 GS11 Supervisor	1 GS11 Supervisor
4 GS09 Contract Specialists	1 GS09 Contract Specialists
7 GS05 Contract Specialists	6 GS07 Contract Specialists
4 GS05 Purchasing Agents	10 GS05 Purchasing Agents
4 GS04 Purchasing Agents	2 GS04 Purchasing Agents
1 GS04 Processing Clerk	

APPENDIX F

PRE AND POST SACONS DOC PAYROLL

Pre-SACONS Payroll

GS LEVEL	NO. OF EMPLOYEES	GS* PAY RATE	TOTAL
GS-12	3	$37,646	112,938
GS-11	4	31,412	125,648
GS-09	11	25,963	285,593
GS-07	6	21,222	127,332
GS-06	2	19,099	38,198
GS-05	20	17,134	342,680
GS-04	8	15,313	122,504
GS-03	14	13,642	190,988
Total	68		$1,345,881

Post-SAXONS Payroll

LEVEL	NO. OF EMPLOYEES	GS PAY RATE	TOTAL
GS-12	3	$37,646	112,938
GS-11	8	31,412	251,296
GS-09	7	25,963	181,741
GS-07	13	21,222	275,886
GS-06	1	19,099	19,099
GS-05	14	17,134	239,876
GS-04	3	15,313	45,939
GS-03	3	13,642	40,926
Total	52		1,167,701

*GS Pay Rate computed using Step 5.

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